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ABSTRACT

Infants' use of auditory information in guiding their search behavior is examined in this study. The subjects were two groups of 9-month-old crawling infants. Group 1 consisted of 24 infants and Group 2 of 16 infants. The auditory stimuli was the mother's voice. Infants in both groups were initially positioned by their mothers behind a screen in a room with two doorways. Once the mothers had surreptitiously left the room, the infants were lured out from behind the screen by two toys placed in the center of the room. Thirty seconds after the infants reached the toys, their mothers called out to them. In Group 1, the mothers called every 30 seconds until the infants began to crawl to one of the two doorways. In Group 2, the mothers called only once. Results from the first trial indicate that infants are capable of using maternal sound cues in guiding their search behavior. There was, however, a significant decline in successful search behavior in the second trial in which the mothers departed through the doorway not used in trial one. The infants' visual behavior--amount of time spent looking at the two open onset of crawling--was also briefly studied. (Author/JA)

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Infants' Use of Sound in Search for Mother During Brief Separation

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Over the past few years, I have been studying how 9 month old crawling infants search for their mothers following a brief period of self-imposed separation in a laboratory setting. The background for this research has drawn heavily on Piaget's (1971) theory of object-concept development and Bowlby's (1969) ideas on the development of active proximity-seeking attachment behavior.

In a first series of studies (e.g., Corter, Zucker, & Galligan, 1980), the infants saw their mothers leave through one of two open doorways. This brief amount of visual information seemed sufficient in guiding successful search in that the majority of infants crawled to the doorway of mother's disappearance after playing for a few minutes with some toys. However, seeing mother leave through a second doorway on a second trial did not yield the same pattern of successful search--the majority crawled back to the doorway where the mother had been seen to disappear on trial one (cf. Zucker & Corter, 1980). These findings parallel reports of infant manual search behavior in some of Piaget's standard object-hiding games.

The study I am going to describe this morning examined the infant's use of auditory information--the mother's voice--in guiding search behavior in the same kind of separation situation I employed when visual information was the cue provided to the infant. My interest in examining the use of sound in guiding search behavior stems from two sources--studies which have assessed infants' use of sound in search for non-social objects and studies which have assessed the specialness of mother's voice in the context of early social development.

A few studies in the literature suggest that auditory information is considerably less efficient than visual information in guiding the infant's search for non-social objects. For example, Uzgiris & Benson (1980) reported that while 9-10 month old infants would orient visually to the sound of a

surreptitiously hidden object, only about half would proceed to successfully recover the object by lifting the cloth which covered it. Their observations are consistent with a few other studies carried out over the past few years (e.g., Bigelow, 1980; Freedman, Fox-Colenda, Margileth, & Miller, 1969) as well as with a number of observations reported much earlier by Piaget on his own infant children.

Because work on the role of sound in search behavior has just begun, it is probably premature in deciding whether the failure to search is due to task-related factors or competence factors. Among a variety of explanations, however, the possibility that a motivational factor is important comes from Piaget's observation that his infants appeared quite content to simply look at the hiding place and listen to the pleasant sound, or even to tap the cloth covering the object in order to reactivate the object's sound-producing properties. Consider one of Piaget's (1971) observations:

> ...the animal is lying under the coverlet...I tap on the goose which then rattles very distinctly. Lucienne imitates me at once, taps harder and harder, and laughs; but it does not occur to her to raise the screen (obs. 31).

By employing mother as the object, I wondered whether the problem of motivation to search might be overcome. In addition, the arbitrary nature of sound-producing non-social objects would not be a problem, given the findings of studies which have shown that infants much earlier in the first year of life are capable of identifying their mother's voice (e.g., Bosso, 1978; Brown, 1979; DeCasper & Fifer, 1980; Mehler, Bertoncini, Barriere, & Jassik-Gerschenfeld, 1978; Turnure, 1971).

Two groups of 9 month old crawling infants participated in the study and the setting of the experiment is shown in Figure 1. Infants in both groups were initially positioned on the X mark by their mothers, who then surreptitious-

ly disappeared through one of the two open doorways. The infants were prevented from seeing the locus of mother's disappearnce by a screen, which is represented by the thin black line adjacent to the X mark. By placing two toys in the center of the room, the infants were successfully lured out from behind the screen. In this position, the infants were about 12 feet away from the two doorways. Thirty seconds after the infants reached the toys, their mothers called out to them by saying "Hi (infant's name), come to Mummy." In one group, which consisted of 24 infants, the mothers called every 30 seconds until the infants began to crawl to one of the two doorways. In the other group, which consisted of 16 infants, the mothers called only once--30 seconds after the infants had reached the toys.

The trial ended after the infants moved to one of the two open doorways, or were retrieved by their mothers due to sustained distress. A second trial was then carried out in which the mothers surreptitiously departed through the doorway not used on trial one. Other than the change in the locus of mother's disappearance, the procedure was identical to the first trial.

As may be seen in Table 1, both groups of infants were successful in searching mother out. In the repetitive-call group, 19 infants searched at mother's doorway, 1 searched at the other doorway, and 4 were retrieved due to sustained distress. In the single-call group, 12 infants searched at mother's doorway, 3 searched at the other doorway, and 1 was retrieved. Thus, in the present study, mother's voice appeared to be an effective cue in guiding their infant's search behavior.

Aside from their motor search, the infants' visual behavior prior to the onset of motoric search was also studied. Visual behavior was defined in terms of the amount of time spent looking at the two open doorways during the course of the trial, but prior to the onset of crawling. As may be seen in Table 2,

both groups of infants looked significantly longer in total at the mother's doorway than at the other doorway.[1]

In thinking about these findings, the behavior of the infants in the single-call group seemed particularly interesting. Like their counterparts in the repetitive-call group, they spent a considerable amount of time--over 4½ minutes on average--away from their mothers. Their success in search is intriguing if you consider that the time between mother's single call and the onset of motoric search was about 4 minutes on average.

To round out the results of trial one, I would like to present one final piece of descriptive information. The infants in the repetitive-call group were exposed to a total of 235 calls from their mothers, an average of 9.2 calls per infants (range, 1-39). Of these 235 calls, 144, or 61%, were responded to within 3 seconds by a look to the mother's doorway.

On trial two, I was particularly interested in examining whether the infants would perseverate in their motor search. To test this possibility most clearly, only those infants who successfully found their mothers on trial one were included in this analysis. From the outset, however, I would like to point out that the results should be considered as tentative for two reasons. First, and most importantly, any evidence for perseveration on the basis of auditory information alone must be treated cautiously since the infants did see their mothers at the first doorway at the end of trial one. (Unfortunately, we weren't clever enough in engineering an "ecologically valid" situation where the mother could reappear behind the screen without her infant seeing her.) Second, not all infants who found mother on trial one provided

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[1] During the 30 seconds prior to the mother's first call, there was no evidence that the infants engaged in selective visual search to her doorway. Across the two groups, 19 infants looked to at least one of the two doorways; of these, 11 looked first to the mother's doorway and 8 looked first to the other doorway. The remaining 21 infants did not look at either doorway. Duration of looking at the two doorways during this time period averaged less than one second/doorway. Thus, there was no indication that the infants had detected which doorway the mother had left through.

usable data on trial two. One-third of the infants began crawling to one of the two doorways before the onset of mother's calls; hence, their records were not included.

The results for motoric search on trial two are presented in Table 3. Across both the repetitive- and single-call groups, 9 infants were successful in finding mother, 8 returned to the doorway where the mother had been found on trial one, and 3 were retrieved. Although these data provide no evidence for perseveration, they do represent a significant decline in successful search (McNemar's test, $p < .01$). As may be seen in Table 3, the single-call group was less likely to find mother on trial two than infants in the repetitive-call group but this difference was not significant. However, if these trends were to continue in a larger sample, a pattern of perseveration would probably emerge in the single-call group.

Table 4 presents the data for the infants' visual behavior on trial two. As was the case with motoric search, there was no evidence for perseveration in looking behavior. According to a Wilcoxon's test, both groups looked at the two doorways for similar lengths of time. Thus, changing the locus of mother's departure appeared to disrupt selectivity in the infants' looking behavior as well.

The results for trial one provided reasonably strong evidence that 9 month old infants are capable of using maternal sound cues in guiding their search behavior. This finding appears to be at variance with reports of infants' use of sound in search for non-social objects. In trying to account for the difference in performance on these two types of tasks, it might be useful to consider how sound comes to signify the permanence of social and non-social objects. In day to day life, infants no doubt have a great deal of experience with hearing their mothers when she is out of sight. This kind

of auditory contact probably occurs much less frequently with sounding non-social objects which are of interest to the infant. Hence, it may be easier for the infant to confer substantiality to the mother's voice than to the sound of non-social objects.

The method of the present study, however, leaves open the question of whether the infants were actually searching for their mothers, or just moving in the direction of a sound per se. Though it is unlikely that the infants did not recognize their mother's voice qua mother, it would be helpful to test this directly. In this context, I would simply like to say that some of our pilot work has indicated that 9 month olds do respond differently to the voice of an unfamiliar person than they do to their mother's voice in our separation situation. If these data hold up, they will provide additional evidence for the specialness of mother's voice in guiding search behavior.

In closing, let me offer just a few comments regarding the infants' developing representation of its mother as a permanent object. The single-call condition of the present study was roughly comparable to our visual departure studies in the sense that the infant is given a relatively small piece of information as to mother's whereabouts. Performance on the two trials in these studies seems to have yielded similar patterns--a good deal of success in search on trial one and a decline in success on trial two. Taken together, these findings may eventually point to the possibility that the infants' developing representation of its mother as a permanent object proceeds at an equivalent rate within the sense modalities of vision and audition, respectively.

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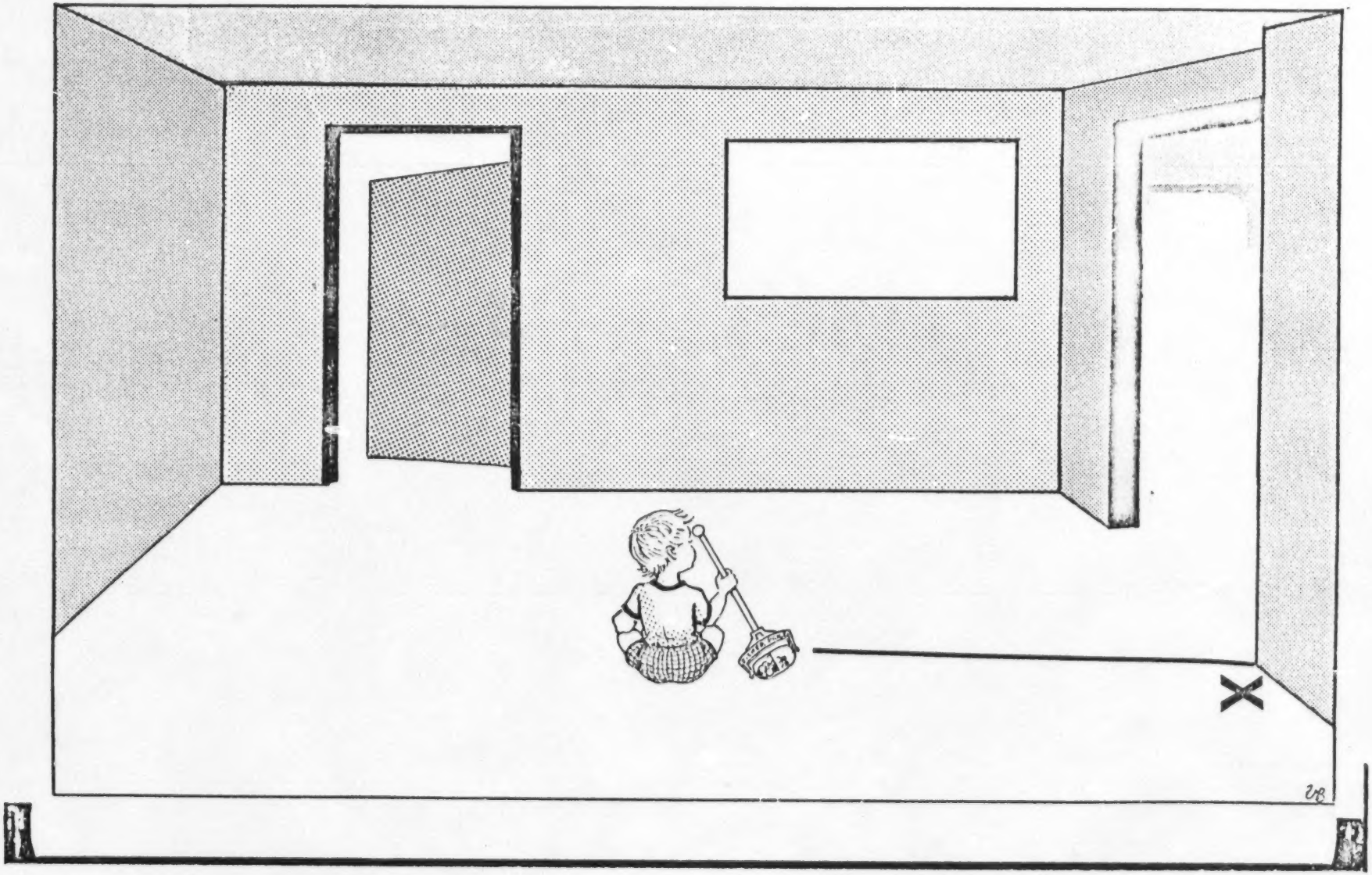

Figure 1. Experimental Setting

Table 1: Locus of Motoric Search (Trial 1)

Group	Locus of Search		
	Mother's doorway	Other doorway	Retrieved
Repetitive-call (n=24)	19	1	4
Single-call (n=16)	12	3	1

Table 2: Duration of Looking Behaviour and Trial Length (in seconds)

Measures	Group	
	Repetitive-call (n=24)	Single-call (n=16)
	$\bar{X}$	$\bar{X}$
Look mother's doorway	15.6**	5.3*
Look other doorway	4.7**	1.7*
Trial Length	338.3	283.7

**$p < .01$ (Wilcoxon's test)

*$p < .01$ (Wilcoxon's test)

Table 3: Locus of Motoric Search (Trial 2)*

Group	Locus of Search		
	Mother's doorway	Other doorway	Retrieved
Repetitive-call (n=12)	7	4	1
Single-call (n=8)	2	4	2

*Based only on those infants who were successful in finding mother on trial one and on whom data were available.

Table 4: Duration of Looking Behaviour (Trial 2)

Measures	Group		
	Repetitive-call (n=12) $\bar{X}$	Single-call (n=8) $\bar{X}$	Combined (n=20) $\bar{X}$
Look mother's doorway	8.3***	3.1**	6.2*
Look other doorway	3.7***	2.4**	3.2*

***n.s. (Wilcoxon's test, T(11)=20.5)

**n.s. (Wilcoxon's test, T(8)=12.5)

*n.s. (Wilcoxon's test, T(19)=62.5)